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ABSTRACT

Large numbers of graduates from the "general" high school curriculum have not developed the academic or technical competencies required for direct entry into the work force or postsecondary education. Tech prep (TP), which has been proposed as an alternative to the "general" high school curriculum, combines the following components: applied academics, a core of technical coursework within a specific professional cluster, and articulation of high school-level coursework with two- or four-year college coursework. TP focuses on technology rather than on science and enables students to develop the following: literacy in technology (in technology education); efficiency in technology (in vocational education); and professional expertise in technology (in associate and baccalaureate degree programs). The following actions are required if TP programs are to give students the competitive literacy required of a world-class work force: (1) include technology education as a core requirement in TP curricula; (2) use SCANS (Secretary's Commission on Achieving Necessary Skills) foundations and technical competencies as a benchmark to upgrade high school-level technology education courses; (3) develop TP curricula that provide entry-level articulation to a wide range of technology-related associate and baccalaureate programs; and (4) develop generous articulation agreements that will encourage teacher support of TP. (Contains 28 references.) (MN)

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ED 373 182

*by Leonard A. Colelli, Ph.D.*

# TECH PREP & TECHNOLOGY EDUCATION

## *A Positive Focus for Competitive Literacy*

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International Technology Education Association

*by Leonard A. Colelli, Ph.D.*

# ECH PREP & TECHNOLOGY EDUCATION

## *Positive Focus for Competitive Literacy*

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# INTRODUCTION

The quality of public education has been a focal point for numerous studies, evaluations, and reports during the past decade. These studies describe how academic and technological illiteracy of high school graduates threatens both our democratic way of life and the economic well-being of our country (Gardner, et al., 1983; Bennett, 1987; Starr,1988; Sagan; 1989, 1991, 1991; The Department of Labor, 1991; and others).

There has always been a positive relationship between the education of our citizenry and economic competitiveness with foreign nations. According to a 1991 Department of Labor report from the Secretary's Commission on Achieving Necessary Skills (**SCANS**), large numbers of individuals are graduating from our high schools without the basic foundation skills and **generic** work related competencies required for either direct entry into a meaningful job or continued education at the post-secondary level. When the failure to properly educate large numbers of future workers is compounded with the globalization of commerce and the exponential growth of workplace technology, it becomes easier to understand why many of our basic industries have failed to remain competitive in global markets.

There is a ground swell of opinion that U.S. citizens must be better educated at the secondary level in both **academic foundations** and **generic career related competencies**. Many feel that this type of "basic" education is essential to better prepare individuals for the type of technology based college level education required to develop a world-class workforce. According to the SCANS commission, nothing short of a **world-class workforce** will allow our nation to regain a competitive advantage in world markets and promote economic growth for the economy.

A major new initiative in education is currently receiving considerable attention across the United States. This initiative, called **Tech Prep**, is designed to provide a focus for a great majority of students who meander through the **"general"** high school curriculum with few career goals or ambitions. These students have traditionally been the **least prepared** for immediate entry into the world of work or for continued education at the post secondary level.

One purpose of this monograph is to define tech prep and examine the need for a tech prep alternative to the "general" high school curriculum. A second purpose is to discuss the role that ***technology education*** can play in an engineering related tech prep curriculum designed to develop **competitive literacy** for a **world-class workforce**.

## THE NEED FOR TECH PREP

There was a time, not long ago, when large numbers of high school graduates could find gainful employment in unskilled labor positions. Since unskilled labor positions required minimal academic and little if any technical skill development, a "general" high school curriculum with these same characteristics adequately served their needs. Special high school curricula were developed for students who desired professional careers that required further academic study (**college preparation**) and for those students who desired specific training for skilled labor positions (**vocational preparation**).

During the past forty years, the entry level requirements for technical careers have changed rather dramatically due to the globalization of commerce and the exponential growth of technology in the workplace. In the 1950's the demand for unskilled workers was about 60 percent of the U.S. workforce. The demand for unskilled workers fell sharply to about 35 percent in 1989 and is predicted to bottom out at about 15 percent by 1995 (Etheridge, 1991).

By the year 2000, more than 70 percent of all job classifications in the United States will require advanced skill levels available only through post-secondary education (Parnell; 1990, p. 4). These careers will demand an educational background that provides a good mix of **applied academic competencies**, a **holistic understanding of technology**, and a broad spectrum of **technical competencies** that are considered **generic** requirements to a variety of related careers.

While the needs of industry have changed to keep pace in a competitive world economy, the "general" high school curriculum has not. According to Parnell (1985), our present system of educating the majority of our youth allows:

- nearly one million youth to drop out of school each year;
- seven out of ten high school students graduate who cannot write a basic letter seeking employment or information about a job;
- three out of five twenty-year-olds to graduate who cannot add up their own lunch bill; and
- one out of eight seventeen-year olds to graduate who are **functionally illiterate**.

The domino effect of large numbers of inadequately prepared high school graduates has had a devastating impact on the economic well-being of our country. The Commission on Industrial Competitiveness (1985) reported that the ***failure to develop our human resources*** is one of the major causes for the decline of American competitiveness. This finding has been echoed in the recent SCANS report from the U.S. Department of Labor (The Department,1991).

After decades of leadership in industry and trade, it has become evident that a poorly prepared workforce has seriously eroded our ability to compete in world manufacturing markets. According to The Atlantic Monthly (March 1983) and Dornbush et al. (1988), our inability to compete in a global marketplace continues to cost our country:

- lost market share;
- plant closings;
- the virtual extinction of basic industries (ball bearings, semiconductors, video

displays, and others) critical to our national security;
- a reduction of well paid value-added production related jobs;
- an increase in the number of low paid service related jobs;
- lower personal income;
- greater foreign trade deficits;
- increased national debt; and
- a lower standard of living for greater numbers of our citizens than the generation that preceded them.

Japan, now the world's number two industrial power, continues to gain ground on us. At the same time, Japanese and Korean investment is financing the development of a whole new generation of export-oriented Asian countries. These "Pacific Rim" countries (Taiwan, Indonesia, Singapore, and others) will soon form a powerful new trading block. Further, the fall of the Iron Curtain and the harmonization of Europe into one European economic market will create other challenges.

Harvard Business School Professor George Lodge recently commented that just as Mikhail Gorbachev forced us to rethink post-war super-power relations, a similar thinking should be focused on economic competition and education for **competitive literacy**. His answer: an "**American Perestroika**" that includes policies that:

1. bolster our overall educational system and
2. encourage young people to pursue certain technology related professions (Chandler, 1989).

The "American Perestroika" that Lodge refers to can be achieved through a properly designed ***tech prep*** curriculum.

The need for adequately prepared students to pursue technology related careers is critical because there appears to be a general downward trend in the production of new engineers, engineering technicians/technologists, scientists, and technology education teachers. Almost all of the specialized engineering disciplines tracked by the New York and Washington, D.C. based Engineering Manpower Commission reflected fewer associate and bachelor-level graduates (November, 1989). Further, the Bureau of Labor Statistics estimates that the United States is facing a sever shortage of engineers (nearly 560,000) and scientists (nearly 400,000) by the year 2010.

Fewer graduates in these areas may be a reflection of a national shift from a goods-producing economy to a service providing economy. However, Ivan Charner (1990), Director of the National Institute for Work and Learning, feels that our country is "very close to a human capital crisis." He suggests that while the U.S. is struggling to keep pace with foreign competition, many of our poorly prepared young people are forced to settle for low skill jobs with "limited prospects of long-term productive employment and limited opportunities for life-long learning." (p. 7)

If our country is to:

- maintain or improve our standard of living for future generations;
- reduce unemployment;
- provide greater numbers of good income earning jobs for our citizens;
- reduce our foreign trade imbalance; and
- eliminate our national debt;

we must take a proactive position in revitalizing our educational system and value-added goods-producing capability. The type of education that we provide to the large number of students in the "general" high school curriculum appears to be a dominant factor in achieving these goals.

## TECH PREP DEFINED

Tech prep has been described in the literature as a **parallel college prep curriculum** designed to replace or provide an alternative to the "general" high school curriculum (see Figure 1). Dale Parnell (1986) refers to students enrolled in the "general" high school curriculum as the "**neglected majority**" because they have never received the financial support, instructional opportunities, and attention that have traditionally been afforded to the college or vocational preparatory students.

Parnell (1985), Hull and Parnell (1991), and others have criticized the "general" high school curriculum because it:

- encourages the lowest expectations of students,
- provides students with no clear career goals,
- represents the easiest path to graduation,
  - -minimal science
  - -minimal mathematics
  - -minimal communications
- has the highest dropout, absence, and tardy rates, and
- least prepares high school graduates for either direct entry to work or post-secondary education.

Large numbers of dropouts and poorly prepared high school graduates have had a devastating impact on the economic well-being of our country. Industry has historically hired many of its entry level workers from high school graduates of the "general" curriculum and has then been forced to spend millions of dollars annually in remedial and supplemental training. If dropout rates could be significantly decreased and high school graduates were better prepared, money could be better spent on the higher level skill development required for a world-class workforce.

Many **community colleges** also find that the majority of their students are graduates of the "general" high school curriculum. These students come to the community college with glaring academic deficiencies in mathematics, science and communication skills. They are then forced to complete up to one year of remedial classes that don't count toward graduation and increase the time and expense that it takes to complete their degree objectives. Academic remediation also places a tremendous financial burden on the schools they attend.

Tech Prep was conceived to bridge the rapidly expanding chasm between school and work. A **properly designed** tech prep curriculum can provide all of the foundation skills as well as generic technical competencies (identified in the SCANS report) essential for the preparation of students, whether they are going directly to work or planning further education.

Federal law defines tech prep as a curriculum that includes **at least** the last two years of high school and two years of post secondary education, with a common core of required proficiency in mathematics, science, communications, and technologies. A major goal of any tech prep curriculum is to enable greater numbers of high school graduates to obtain associate degrees or certificates in specialized career fields. Many existing tech prep programs begin in ninth grade and continue for at least two years of postsecondary education.

Most tech prep curricula include at least three major components:

1. an **applied academic course of study** that includes grade level or above mathematics, science, and communication skills;

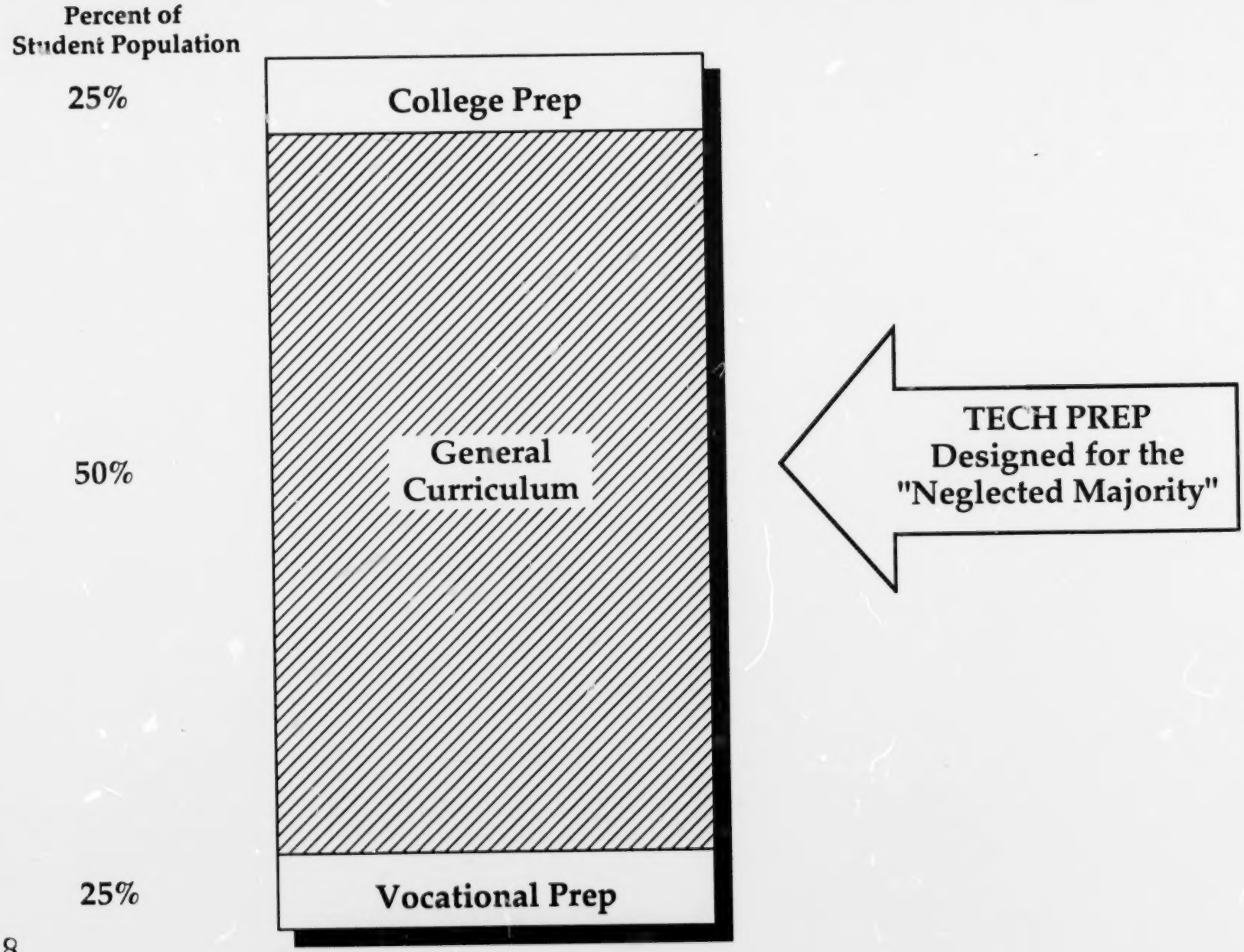


Figure 1: Conventional High School Curriculum

2. a **required technical core** of classes related to a specific occupational cluster of careers; and

3. **articulation** of coursework with community and four year colleges/ universities to encourage advance level education and career related skill development.

## Applied Academics

The historic solution to education reform has been to increase the number of "academic" classes required for graduation from high school. Many have also recommended foreign language requirements to provide students with a global perspective of other cultures. Almost all conventional solutions have called for a reduction in the number of electives, particularly in the humanities and technologies.

There is nothing new about this kind of "basics" curriculum. It simply represents a downward extension of the existing college preparation track of most high school curricula. The major problem with the above solution is that it fails to recognize the individual differences and learning styles of our students.

Practical experience has shown that a wholesale increase in theory-laden academic coursework tends to promote frustration, higher failure and drop-out rates, and increased classroom behavior problems for "neglected majority" students (Parnell, 1985; Pedrotti, 1991). However, the literature is replete with examples of how these barriers to educational achievement are significantly reduced and greater learning takes place when the curriculum is designed to match the specific learning style of the students that it serves. This has already been done for college and vocational preparation students. With tech prep, the same logic is now being extended to the "neglected majority".

Cognitive research has indicated that the "neglected majority" learn best when educational experiences are designed to progress from concrete to abstract with a generous portion of real world activity-based applications added to reinforce theoretical concepts (Pedrotti, 1991). The bottom line is that these students can learn the same things that "college prep" students can learn, but the learning environment must be modified to their distinct learning style. The term "applied academics" is used to identify mathematics, science, and communications classes that are designed with the above characteristics.

Commercially prepared high school and college level "applied academic" materials have been developed by the Center for Occupational Research and Development (**CORD**) in Waco, TX and the Agency for Instructional Technology in Bloomington, IN. Four "applied academic" courses currently available in many tech prep programs include two year sequences in applied physics ("Principles of Technology"), "Applied Mathematics", and "Applied Biology/Chemistry" as well as a one year course in "Applied Communication." All of these courses include a student textbook (with laboratory activities), video tapes, a teacher's guide, a bank of test questions, and a resource guide (Pedrotti, 1991).

The commercially prepared "applied academic" courses can be directly integrated into the tech prep curriculum or can serve as models to help conventional academic teachers design their own applied classes. An important point of concern here is that applied classes are NOT just watered down versions of college prep classes. The grade level or above integrity of the classwork must be maintained. The pace is slower and therefore, the time it takes to cover the traditional content will probably be extended. The additional time will be required so that practical applications and hands-on experiences

can be added. The primary goal is to provide greater numbers of high school students with a solid foundation in math, science, and communication skills using a delivery system compatible with their unique learning style.

## The Technical Core

The second component common to tech prep curricula is the technical core. These are the classes that should provide technological literacy and the basic career related skills that are now required for entry level positions in the workforce. The technical core must also be designed to provide coursework that is compatible with the technical requirements of the first semester or year of a related associate degree program at a community college. This is where articulation will take place.

The technical core of most tech prep models follows a career-cluster design. The logic of this approach is based on the fact that most occupations can be grouped into major clusters that require similar skills and knowledge. According to Hull (1992) and others, career clusters that have commonly been used in tech prep programs include:

- engineering/industrial,
- health/human services,
- business careers,
- agricultural, and
- arts/humanities.

An additional career cluster specifically designed for teacher education could have a positive impact on low enrollment, predicted teacher shortages, and the current pressure to either add a fifth year or reduce the number of technical core competencies related to the program of certification. Shifting required entry level technical classes to the high school curriculum would help to offset the trend toward significant increases in professional education and general studies core requirements at the college/university level.

The technical core of many conventional tech prep programs tends to focus on a **vocational education** format. An example engineering/industrial core might include combinations of **ONE TO THREE CLASSES OR YEARS** of auto technology, carpentry, metals technology, technical drafting, computer aided drafting, graphic arts, electronics, masonry, industrial maintenance, horticulture, textile technology, or machine shop. The depth of study and combination of classes depended on the specific occupation within the career-cluster that is selected.

There are **many problems** with the vocational Tech Prep approach. First it forces adolescents to make **highly specific, narrowly focused career choices** as early as the eighth grade. Second, the focus of post-secondary education is only on the community college. Even the conventional name "Tech Prep Associate Degree" or **TPAD** reflects this limiting mentality. Further, the scope of the **technical core is unbalanced.** Since the technical core of the vocational format focuses on a concentration of classes in **one particular occupation (i.e. Drafting or electronics)**, technical skill development is severely limited to that occupation. A holistic understanding of technology (technological literacy) and the systematic attainment of generic workplace competencies (recommended by the SCANS commission) cannot be achieved.

The foundation skills and generic workplace competencies identified by the SCANS commission are listed below.

**I. Foundation Skills:**

- ***Basic Skills*** -- reading, writing, arithmetic and mathematics, speaking, and listening.

- ***Thinking Skills*** -- thinking creatively, making decisions,

| | Conventional Tech Prep (Vocational Format) | North-Central WV Tech Prep (Generic-Technical Format) |
|---|---|---|
| 8th Grade | Select ***Occupational Cluster*** as well as ***Specific Career*** | Select Only an ***Occupational Cluster*** |
| H.S. | Multiple Technical Classes in ***One Specific Career*** (i.e. Electronics, Nursing, etc.) | Wide Variety of Literacy & Generic Technical Courses Apply to ***Many Technology Related Careers*** |
| College | Focus ***Only on Community College*** With Degree Option Limited to H.S. Vocational Concentration (i.e. Electronics, Nursing, etc.) | Can Articulate into a ***Wide Variety of A.S. and B.S. Degree Programs*** (Electrical, Safety, Mechanical, Architecture, Civil, Manufacturing, etc.) as Well as Teacher Education |
| Scope | Unbalanced Technical Core Achieves ***Some SCANS*** Foundations/Competencies | Balanced Technical Core Achieves ***ALL SCANS*** Foundations and Competencies |
| Goal | ***Vocational Efficiency*** | ***Competitive Literacy*** |
| Career Path | H.S. Diploma, A.S. (***Technician***). Many Vocational A.S. Degree Programs ***DO NOT*** Lead to B.S. Degree Programs | H.S. Diploma, A.S. (***Technician***), B.S. (***Technologist***), E.I.T., P.E. (***Engineer***), ***Teacher***, and Beyond |

Figure 2: Tech Prep Technical Core Dichotomy

solving problems, seeing things in the mind's eye, knowing how to learn, and reasoning.

- ***Personal Qualities*** -- individual responsibility, self esteem, sociability, self-management, and integrity.

**II. Workplace Competencies:**

- ***Resources*** -- allocating time, money, materials, space, and staff;

- ***Interpersonal Skills*** -- working on teams, teaching others, serving customers, leading, negotiating, and working well with people from culturally diverse backgrounds;

- ***Information*** -- acquiring and evaluating data, organizing and maintaining files, interpreting and communicating, and using computers to process information;

- ***Systems*** -- understanding social, organizational, and technological systems, monitoring and correcting performance, and designing or improving systems; and

- ***Technology*** -- selecting equipment and tools, applying technology to specific tasks, and maintaining and troubleshooting technologies. (The Department of Labor; 1991, p. vii)

A **balanced technical core** that includes a holistic understanding of technology (technology education) and technical competencies generic to a wide variety of related occupations is required to achieve SCANS competencies and produce flexible graduates that will help our country achieve a world-class workforce capable of competing in a global economy.

Finally, the vocational tech prep format tends to **limit the career ladder** potential of graduates to the **technician level** within the specific occupation selected. Since students are required very early to select a specific occupation and are tracked in that occupation throughout high school, they must select that same field of study at the associate degree level and enter the workplace as a technician in that occupation. The further one gets in the high school curriculum, the less career flexibility is available. If baccalaureate degree programs do not exist in the selected occupational area, the door to career advancement is usually closed. The graduate must then begin the process again in another occupational area that will lead to a four year degree or beyond.

The North-Central West Virginia (NCWV)Tech Prep Project developed an alternative engineering related technical core based on a literacy and **generic-technical format.** Future technical cores for business/commerce and health/human services clusters will also be based on a literacy/generic-technical format rather than a vocational format.

A comparison between the conventional vocational format and the generic-technical format is illustrated in Figure 2. This alternative (generic-technicall) core addresses all of the shortcomings of the vocational format by:

1. incorporating generic entry level engineering related competencies,

2. including broad-based systems courses to provide literacy in technology (as recommended in the SCANS report), and

3. articulating these literacy and generic technical competencies into a wide variety of two and four-year engineering-related degree programs.

The primary goal of the generic-technical format is to develop a new form of literacy for our workforce called **competitive literacy.** This generic-technical format as well as the concept of competitively literacy will be discussed in greater detail later in this monograph.

## Articulation

Articulation is an important part of any tech prep program. It is a process by which educators at the secondary level work together with educators at the post-secondary level to link their programs and eliminate unnecessary duplication of coursework. Articulation between secondary and post-secondary classes can take place in academic as well as technical classes.

Articulation basically involves the following process. Secondary and post-secondary representatives are first appointed to direct the overall articulation effort. Academic and technical articulation committees are established for each class that is to be articulated (i.e., math, science, language arts, engineering graphics, computer graphics, electronics, manufacturing, transportation, etc.). Subject matter experts from the secondary level and the post-secondary level are then appointed to each committee. Each committee should also include industrial representatives.

A kick-off meeting involving all committees is usually held to get the articulation process formally started. One or more speakers from industry is asked to explain their view of the overall importance of a good tech prep program for the local community and nation. The process of articulation is than explained, a good meal is provided, and then each committee meets briefly to elect a chairperson, develop a curriculum articulation plan, and set up future working meetings.

The goal of future meetings is to determine if existing secondary level classes are compatible with their counterparts at the post-secondary level. Those that are not compatible can either be revised or new secondary level classes can be developed to achieve this goal. Course descriptions, course outlines, goal statements, competency statements, and a final competency examination are developed for each secondary level class that is to be articulated with the college.

Once the committees have worked out all of these course details, the college faculty and administration will draft an articulation policy for advanced placement into the college. Once approved, the articulation policy will be signed by the college president and the superintendent of each participating secondary school system. An in-service training program will later be developed to provide secondary level academic and technical instructors with any competencies required to teach new or revised classes. Advanced placement generally allows articulated credit to be granted to high school graduates who:

1. complete each articulated secondary level class with a predetermined grade point average (usually 3.00 or better),

2. pass a competency examination for each class in the articulation agreement designed by the college instructors, and

3. enroll in a related associate degree program within a certain time period after graduation (usually three years).

An additional requirement that each secondary level class will meet least **twice as many contact hours** as the college level class was added to the NCWV Tech Prep articulation agreement to assure accrediting bodies (such as the Technology Accreditation Commission of the Accreditation Board for Engineering

and Technology -- TAC/ABET) that the high school students were receiving equal to or greater coverage of materials required for each class. After students enroll in college, they can then either complete the associate degree program at less cost, complete additional advanced level coursework to better prepare them for work, or continue their education in a related bachelor's degree program.

## Federal Funding for Tech Prep

In October of 1990, a line item of 63.4 million dollars in federal funding from the Carl D. Perkins Vocational and Applied Technology Education Act Amendments of 1990 was provided to encourage secondary education to join with community colleges to facilitate the development of tech prep programs across the nation (Dervarics, 1990). A national tech prep project was established by the U.S. Secretary of Education to assist states who desire to develop tech prep curricula. Tech prep consortia have received funding by responding to requests for proposals (RFP's) from state grant programs established for this purpose. As of the time of this printing, over 1,000 tech prep consortia have been established across the United States.

Fairmont State College and twelve counties within the north central region of West Virginia formed a tech prep consortium during the summer of 1991. A grant proposal was submitted and approximately $176,000 in federal funding, renewable for three years, was awarded to **plan** (1991-92), **develop** (1992-93), **implement** (1993-94) and **evaluate** (1994 and beyond) this project. Funding for the second year was approximately $180,000 and third year funding has exceeded $200,000. The initial focus was to develop and implement an **engineering technology** tech prep curriculum. Future career clusters will include **business/commerce** and **health/human services.**

Participating counties in this consortium can articulate approved classes with **ten associate** and **ten baccalaureate** degree programs (including technology teacher education) in the Fairmont State College Division of Technology. Since most of these technology and engineering technology degree programs are designed on a **2 + 2 format**, and some are TAC/ABET accredited, the educational career ladder for tech prep graduates in the North-Central West Virginia Consortium can continue from high school, to the associate degree, to the baccalaureate level, to teacher, to engineer and beyond as described in Figure 2.

## THE "TECH" NOLOGY OF TECH PREP

Before a tech prep curriculum that focuses on competitive literacy can be designed, a much better understanding of technology and how it is taught is required. Common public misconception of technology focuses on computers, equipment, and "other gadgets". Most valid definitions describe a codified body of knowledge.

Technological Knowledge is the knowledge (ology) of technique used by humans to change their environment so that wants and needs are satisfied. The New Encyclopedia Britannica (1990) appropriately defines technology as "the systematic study of techniques for making and doing things" (Vol. 28, pg. 451).

### Differences between Science and Technology

The terms science and technology are used together so often that many also confuse the study of technology with the study of science. The relationship between science and technology can be seen in Figure 3. These two disciplines have distinctly different knowledge bases, aims, purposes, goals, careers, processes and impacts.

***Science*** is concerned with the knowledge of what is and the aim of science is to produce and classify knowledge so that logical patterns in nature can be discovered and described. The process of a **scientist** (referred to as the "**scientific method**") involves:

- making careful observations of phenomena,
- collecting accurate data,
- inventing theories (hypotheses) to explain observations,
- testing the validity of theories and
- improving or discarding these theories.

The impacts of science take time to develop and are usually not immediately sensed by individuals.

***Technology*** focuses on the knowledge of technique or practice for making and doing things. The aim of technology is to produce products or develop processes that extend human abilities. Technology is applied by technicians, technologists, and engineers to control or change the world to satisfy human needs. The process of a **technologist** (referred to as the "**technological or engineering method**") involves:

- **defining** human needs,
- **designing** solutions (products/processes, etc.) to satisfy these needs,
- **constructing** solutions (mockups, prototypes, final products),
- **testing** solutions,
- **evaluating** the effectiveness and impacts of these solutions and
- **refining** the solutions.

The impacts of technology are usually felt immediately by all that it touches.

The knowledge and method of technicians, technologists, and engineers is similar, but distinctively different from the knowledge and method of a scientist. However, an understanding of both technology and science are **equally as important** for a liberal education and the development of a "world-class" workforce in a democratic society.

Generally, disciplines in technology have three common characteristics These disciplines:

1. depend on and draw theoretical concepts from the **formal** (math, syntax, logic), **descriptive** (sciences), and

| | Science | Technology |
|---|---|---|
| Knowledge: | Of What Is | Of How to Do<br>(Technique or Practice) |
| Aim: | To Produce And<br>Classify Knowledge | To Produce Products or<br>Processes that Extend<br>Human Abilities |
| Purpose: | Discover Patterns in Nature | Change the World to Satisfy<br>Human Needs |
| Goal: | Show Logical Proof of<br>Abstract Connections | Make the World Manipulable |
| Careers: | Scientist | Engineer, Technologist or Technician |
| Process: | How to Study Something:<br>• Making careful observations of phenomena<br>• Collecting accurate data<br>• Inventing theories to explain observations<br>• Testing theories<br>• Improving or discarding theories | How to Make Something:<br>• Defining human needs<br>• Designing solutions (products/processes) to satisfy human needs<br>• Constructing solutions<br>• Testing solutions<br>• Evaluating effectiveness and impacts of solutions<br>•Refining solutions to human needs |
| Impacts: | Future | Immediate |







Figure 3: Discipline Dichotomy Between Technology & Science

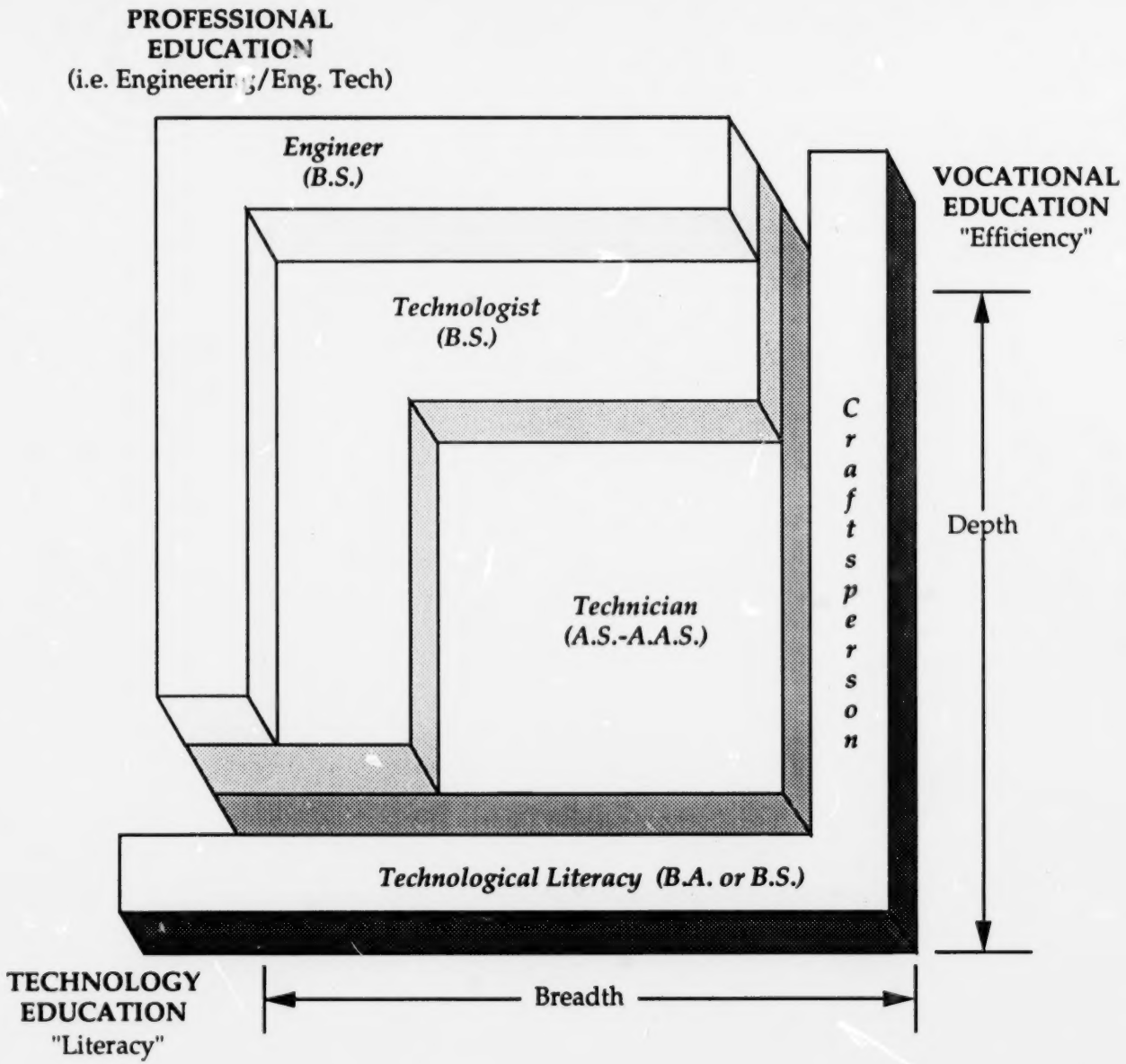


Figure 4: Three Ways To Study Technology

**prescriptive** (humanities) domains of knowledge;

2. demand a clinical or professional body of knowledge called the **theory of practice** or **knowledge of technique** (technology); and

3. require practice, internship, residency, or student- teaching necessary for proper training (Towers et al.; 1966, p. 9).

Secondary education classes in vocational and technology education are attempts to organize such knowledge. The technological domain is represented in higher education by various professional schools such as education, medicine, law, engineering, engineering technology, dentistry, pharmacy, and others.

The engineering and engineering technology fields of study, for example draw a significant amount of knowledge from mathematics and science and have their own unique knowledge base of techniques or practices within each specific field (civil, electrical, manufacturing, mechanical, etc.). They also require college level laboratory practice as well as post-graduate internship as part of the registration process of becoming a professional engineer (P.E.). The same can be said for all of the other fields of study listed above.

## Ways to Study Technology

There are three basic ways to study technology:

1. ***literacy*** in technology (technology education);

2. ***efficiency*** in technology (vocational education); and

3. ***professional*** *or post-secondary* education in technology.

Figure 4 illustrates the relationship between these three ways of studying technology.

## Literacy in Technology (Technology Education)

Technology education has been referred to as the **"NEW BASIC"** in education by the International Technology Education Association. The primary goal of technology education is to promote **technological literacy**. Therefore, breadth is of greater importance than depth in knowledge and manipulative skill development (as illustrated in Figure 4).

Technology education emphasizes:

- major systems of technology;
- resources or inputs to technological systems;
- applications of technology;
- predictive technological concepts;
- cultural understanding;
- problem solving;
- holistic long-term learning;
- interpersonal skills relating to teamwork, leadership, follower-ship, and customer service,
- the acquisition and organization of data through computers, consumer surveys, and other means; and
- applications of the "technological or engineering method".

The above characteristics of good technology education programs relate remarkably well to the development of the five generic workplace competencies identified by the SCANS commission.

SCANS competencies are considered critical to the preparation of a world- class workforce. Further, curricular methodologies that emphasize applications of ***both*** **the technological and scientific methods** can provide students with additional SCANS "Foundations" (basic skills, thinking skills, and personal qualities) described earlier.

The content and activities for teaching **literacy in technology** (Technology Education) are derived from an analysis of common technological systems that humans have historically used to adapt or change their environment for the purpose of satisfying needs and wants. Four basic technological systems have evolved that enable humans to:

1) **CONSTRUCT** shelter and other structures,

2) **MANUFACTURE** their tools, weapons, clothing and food,

3) **COMMUNICATE** ideas and information, and

4) **TRANSPORT** themselves and their supplies to new locations where food and other resources were readily available.

These **technical human-adaptive systems** enabled our primal ancestors to survive their environmental hardships and predatory adversaries.

Sociologists and anthropologists generally agree that these four basic technological systems transcend human existence, cut across cultural boundaries and continue to be the chief agency of social and cultural change in any society (Hales and Snyder, 1981). Therefore, the four major content areas for promoting literacy in technology are ***communication, construction, manufacturing, and transportation systems.***

## Efficiency in Technology (Vocational Education)

A second type of education in technology is called **vocational education.** Vocational education is the ***antithesis*** of technology education (also see Figure 4). The primary focus of vocational education is learning the applied skills of a craftsperson (skilled laborer) and related information required to **efficiently** perform a specific occupation. About 80 percent of the vocational student's time is spent practicing technical job related skills and about 20 percent is spent learning related job information (Pond; 1990, p. 11).

The required skills and related job information for vocational education are determined from a detailed analysis of a particular trade or job listed in the U.S. Dictionary of Occupational Titles. This **trade and job analysis** approach, or a more recent variation called DACUM (Developng a Curriculum) analysis, is designed to develop curriculum that will prepare individuals for selected occupations such as cabinetmaker, secretary, metal machinist, carpenter, welder, drafter, beautician, auto mechanic, printer, and others. An individual who has completed secondary level vocational and post-secondary apprenticeship training in a specific vocational career is typically called a **SKILLED CRAFTSPERSON**.

A further comparison of technology (literacy) education and vocational (efficiency) education is illustrated in Figure 5. One can readily see that the analysis approaches for determining content and method, content focus, class names, goals and purposes of the two educational methods are ***completely different***.

The goal of technology education is **technological literacy** and its major purpose is for the holistic understanding of technology for the liberal education of ***ALL*** citizens in a democratic society. Technology education also serves as a wonderful foundation for individuals who are interested in pursuing an engineering related career.

On the other hand, the goal of vocational education is **vocational efficiency.** Its purpose is to prepare individuals to be technically competent in a specific occupation or job. Therefore, the ultimate goals of technology and

| | Vocational Education (CIRCA 1850) | Technology Education (CIRCA 1981) |
|---|---|---|
| Analysis Approach: | Trade and Job | Technical Human-Adaptive Systems |
| Content Focus: | Narrow | Broad |
| Method of Instruction: | Drill & Practice | Technological Method/ Problem Solving |
| Class Names: | Carpentry/Woodworking<br>Printing/Graphic Arts<br>Drafting/CAD, Electronics,<br>Metalworking/Welding,<br>Machine Shop/Trades, etc. | Communication<br>Construction<br>Manufacturing<br>Transportation |
| Goal: | Vocational Efficiency | Technological Literacy |
| Purpose: | Prepare for a Specific Trade or Job | 1. Liberal Education<br>2. General Knowledge of Industry<br>3. Generic Workplace Competencies (SCANS) |





Figure 5: Curricular Dichotomy Between Technology Education & Vocational Education

vocational education are quite different as well as the methods that are used to achieve these goals.

## Professional (Post-Secondary) Education in Technology

A third type of education in technology develops entry level ***professional*** expertise in a technology related field such as architecture, engineering, agriculture, education, medicine, law, and others. For the purpose of this monograph, **professional education in technology**, (also illustrated in Figure 4) involves the completion of a two, four, or five year college/university degree in an engineering related discipline such as electrical, mechanical, manufacturing, civil, occupational health/safety, mining, aviation, and others.

These professional and pre-professional fields of technology are much broader than occupational areas of vocational education, incorporate greater amounts of applied academic knowledge, and emphasize problem solving and the technological/engineering method compared to the common vocational method of drill and practice. Professional (post-secondary) education in technology (in an engineering related field) prepares individuals to **develop solutions for specific problems** relating to consumer product design and development, industrial competitiveness, housing and urban development, power generation, transportation, communication, waste disposal, global warming, acid rain, depletion of natural resources, and many others.

The graduate of an associate degree program in engineering technology is called a **TECHNICIAN**. The associate degree program represents about a 50-50 percent blend of theory and practice (Pond; 1990, p. 11). This person generally assists technologists and engineers and tends to be actively involved in the maintenance and repair of equipment and facilities.

The graduate of a bachelor's degree program in engineering technology is called a **TECHNOLOGIST**. The Bachelor of Science in Engineering Technology program is about 60 percent theory and 40 percent applied knowledge and practice (Pond; 1990, p. 11). This person generally assists engineers, performs many applied engineering functions, and can become involved in some product/process design applications.

The Bachelor of Science in Engineering program is about 70 percent theory and 30 percent practice (Pond; 1990, p. 11). The primary difference between engineering and engineering technology is the degree of application. "Engineering technologists generally deal with practical design and production work rather that the more theoretical, scientific and mathematical knowledge that is typical of the engineer. Engineering technologists specialize in the same fields as engineers and typically bridge the gap between the engineer and the technician." (Griscom, 1993).

Bachelor degree graduates of ABET accredited engineering and engineering technology programs can eventually become **PROFESSIONAL ENGINEERS** (PE's). Professional engineers tend to be heavily involved in design applications, supervision, and scientific research related to materials, processes, products, equipment, facilities, as well as applying knowledge obtained from the scientific method to solve problems or satisfy human wants.

## Parallel Lineages of Education in Technology

The three ways to study technology described above can be historically traced through two distinct but related parallel lineages as illustrated in Figure 6. The **general education**

**(literacy) lineage** began with experiential learning advocates (such as Bacon, Locke, Commenus, Rousseau, Pestalozzi, and Dewey) from the 1500's through the 1800's. Educational movements such as ***Sloyd*** (usable product), ***Arts and Crafts*** (design), and ***Manual Training*** (tool skills and step-by-step exercises borrowed from Della Voss's Russian System) contributed to the ***Manual Arts*** Movement during the late 1800's. During the 1900's, a multitude of curricular analysis techniques developed the general education lineage from ***Industrial Arts*** to ***Industrial Technology Education***, and finally to ***Technology Education***.

Some futurists in this field have predicted a greater alliance with engineering that may lead to a future name for the field such as ***Engineering Technology Education***. The major goal for all of the above educational movements continues to be **literacy** in technology.

The **occupational lineage** can be traced as far back as the apprenticeship guilds of the Roman empire. During the industrial revolution, the world economy shifted from agrarian to industrial and the apprenticeship system couldn't keep pace with demand for skilled workers. Additionally, the new industrial society had need for special workers with a broad mixture of academic and technical skills similar to those found in military engineering.

A branch of engineering related to civilian (Civil) applications was developed at the Rensselaer Polytechnic Institute during the early 1800's. However, widespread engineering related education was not available in the United States until the Morrill (Land Grant) Act of 1862. This legislation provided land and money for each state to develop a major college level (**professional**) school for teaching ***Agriculture and Mechanic Arts Education***.

While the land and money was appropriated to build new professional schools to service large numbers of individuals, an efficient system of educational instruction for engineering and technology related disciplines was still needed. This system (Victor Della Voss's ***Russian System*** of Tool Skill Exercises) was discovered at the Philadelphia Centennial Exposition of 1876. Calvin Woodward applied the Russian System of instruction for his literacy based ***Manual Training*** instruction in the St. Louis, MO public schools. John Runkle applied the Russian System for his ***Mechanic Arts*** post-secondary professional instruction at the Massachusetts Institute of Technology (M.I.T.).

During the early 1900's it became apparent that secondary level technical instruction was needed to prepare highly skilled (**efficient**) workers within specific occupations related to agriculture, industry, and home economics. This training (called **vocational education**) was funded by the Smith-Hughes Act of 1917.

Vocational (efficiency) education was targeted for those who desired to enter directly into the workforce or apprenticeship training immediately after graduating from secondary level education. As previously discussed, this form of secondary level technical instruction follows a parallel (**occupational**) lineage, but has a completely different content analysis method, method of instruction, goals and learning activities when contrasted with technical instruction for acquiring **literacy** in technology.

Post-secondary (**professional**) education in technology dramatically changed due in large part to another Russian connection during the mid 1950's. After the Russians launched their Sputnik Satellite in 1957, a tidal-wave of mathematics, science, and experimental inquiry (research) became a dramatic focal point for education in this country. This new educational direction was essentially a crash effort to make-up

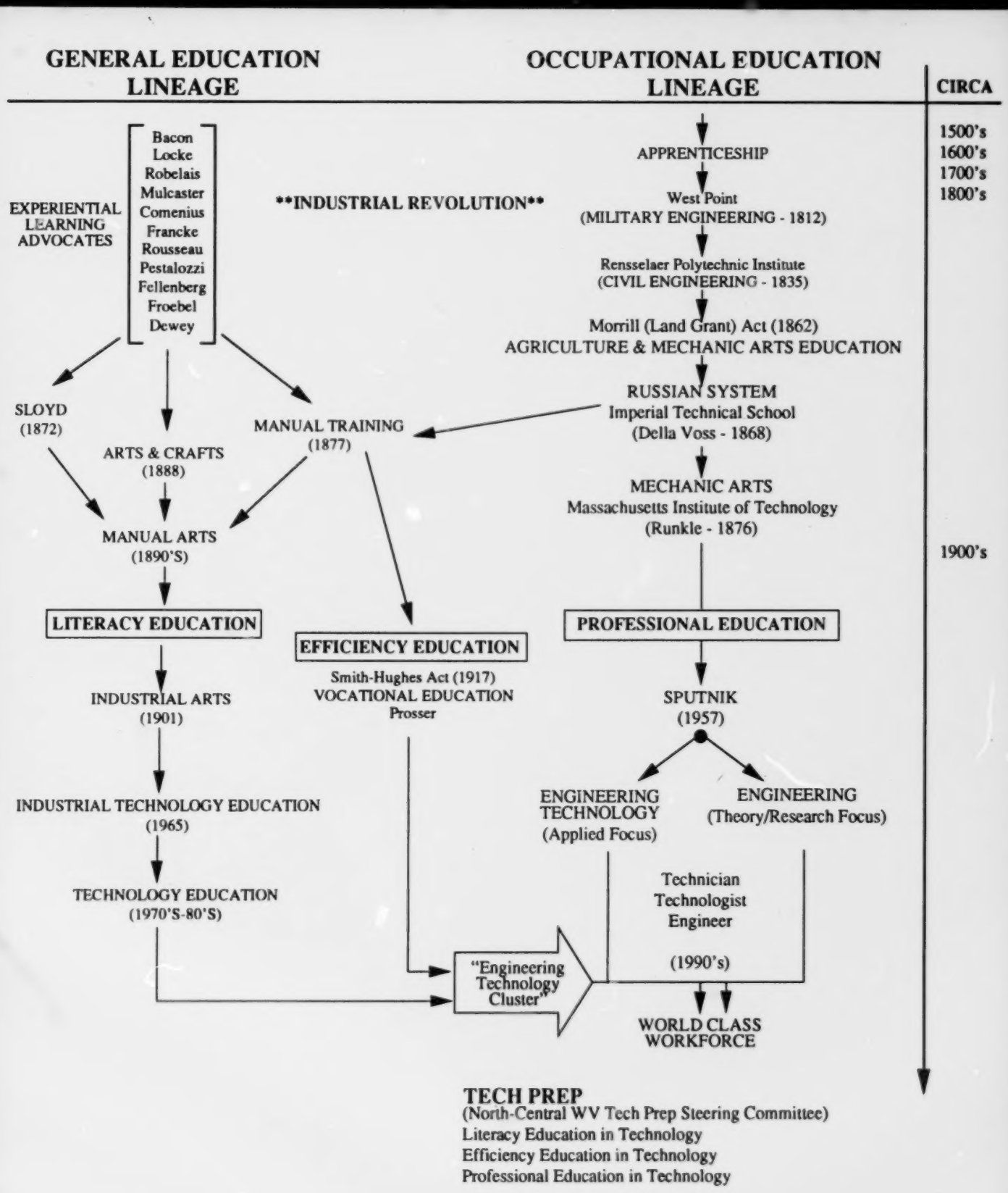


Figure 6: Parallel Lineages Of Education In Technology

lost ground to the Russians in the space program and other technological endeavors. This dramatic change caused professional (engineering) education to split into two related but distinct forms of education. **Engineering** assumed a calculus-based theoretical/research/design focus and **engineering technology;** an applied focus as previously discussed.

An **engineering related tech prep cluster** can be a the binding force (please refer to the bottom of Figure 6) that combines two historic parallel lineages of education in technology (literacy education and occupational education). A **generic-technical** tech prep format (as previously discussed) can also combine all three ways of studying technology (**literacy, efficiency**, and post-secondary **professional**) into a powerful curriculum to develop competitive literacy and a world-class workforce.

## EDUCATION FOR COMPETITIVE LITERACY

Competitive literacy has been suggested by corporate leaders and concerned educators as a focal point for the "neglected majority" in the high school curriculum. The components of competitive literacy, illustrated in Figure 7, begin with a strong foundation in applied mathematics and communication skills (**Functional Literacy**). The desired functional skills include oral, visual, reading, and written communication as well as algebra level mathematics and basic statistics. This is the "basic skill" foundation recommended in the SCANS report.

The second building block for competitive literacy requires educational experiences from both the **descriptive** (sciences) and the **technological** domains of knowledge. Included are the abilities to:

- identify human needs;
- obtain information;
- form and test hypotheses;
- make informed decisions;
- design, produce, and market products;
- solve problems;
- demonstrate constructive work habits;
- work collectively in teams toward common goals; and
- quickly adapt to changing environments.

The above skills represent a ***dual focus*** of the "**Technological**" and **Scientific" methods**. This focus addresses the "thinking skill" and "personal quality" foundations as well as the five generic workplace competencies recommended by SCANS. A combined emphasis in both **scientific and technological literacy** is an essential component of a curriculum designed to develop a world-class workforce.

The third building block for competitive literacy is post secondary education in an engineering or engineering technology related degree program (see Figure 7). The need for adequately prepared students to pursue technology related careers is critical because, as previously discussed, there is a predicted need for about one million new engineers, engineering technologists, and scientists by the year 2010 (Engineering Manpower Bulletin; November, 1989).

The goal of competitive literacy cannot be achieved without the cooperation of four major groups of teachers (as illustrated in Figure 7). **Academic teachers** provide students with functional and scientific literacy. **Technology education teachers** provide technological literacy. **Vocational educators** provide many of the generic entry level technical competencies that will articulate directly into the first year of a technology related post secondary degree program. Finally, educators from **professional** degrees programs in technology (such as engineering technology) at the associate and baccalaureate levels provide advanced level academic and technical classes. All of these disciplines of education are required and cooperation between all is essential for the goal of competitive literacy to be achieved.

### High School Curriculum for Competitive Literacy

There is a significant need to replace the general high school curriculum with a tech prep alternative (as illustrated in Figure 8) that will:

- bring focus, provide goals, and raise expectations;

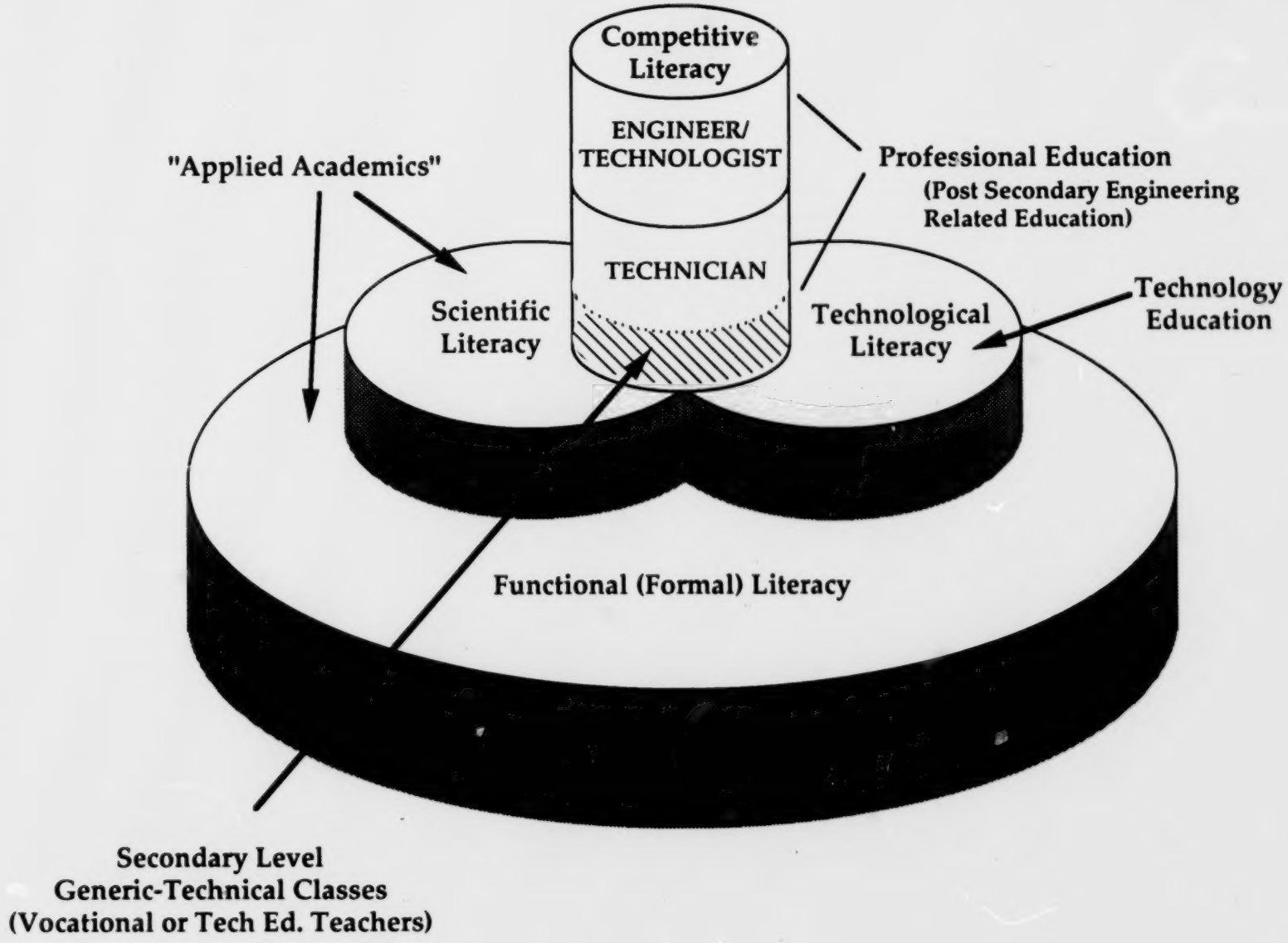








Figure 7: Components Of Competitive Literacy

- require **grade level or above "applied academic" preparation** (math, science, language arts) to adequately prepare high school graduates for entry into either the world of work or college;

- provide a **required technical core** composed of both:

  1. **literacy courses in technology** (communication, construction, manufacturing, transportation), as well as

  2. **entry level technical courses** (such as electronic circuit analysis, engineering graphics, materials and processes, computer graphics, and statics) that are considered **generic** requirements to a wide variety of engineering or engineering technology careers;

- develop **articulation** agreements for selected "applied academic" and technology courses with two and four year engineering, engineering technology, and technology teacher education programs to encourage students to pursue post-secondary level technology related degrees; and

- incorporate an **arts/humanities** sequence (music, literature, art) to humanize future engineers, technicians, technologists and teachers for cooperative and benevolent association with each other and the world they will soon begin to alter.

Graduates of this type of high school curriculum are better prepared for direct entry into the workforce; are better prepared to enter a post secondary level two or four year engineering, engineering technology, or technology teacher education program; and may articulate a significant number of credit hours at the post secondary level.

A model high school tech prep curriculum proposed for the North-Central West Virginia (NCWV) Tech Prep "engineering technology" career cluster is illustrated in Figure 9. This curriculum incorporates multiple trackings in mathematics and science to provide flexibility for "neglected majority" students as well as college prep or vocational students who may wish to take advantage of technical and applied academic classes to prepare for engineering or teacher education related careers.

A summary of this engineering technology tech prep curriculum includes four **mathematics** and **language arts** units, at least three **natural science** units (including Principles of Technology); three **social science** units; one unit each of **health and physical education**; one unit **arts/humanities**; two **elective** semesters of either keyboarding, computer science public speaking and/or applied communication and seven units of **technical classes:**

- 2 units of **literacy** (manufacturing/construction, transportation/communication) and

- 5 units of **generic-technical** (materials and processes, engineering graphics, computer graphics, electronic circuit analysis, and statics).

A majority of the technical core is scheduled for the junior and senior years at either the local high school or area vocational/technical center. These technical classes require a break from the traditional one class, three hour a day vocational format. Students will be scheduled for three generic entry level engineering related classes a semester at either the local high school or the vocational-technical center; each meeting for one hour per day. This model provides options for students with different career objectives, brings

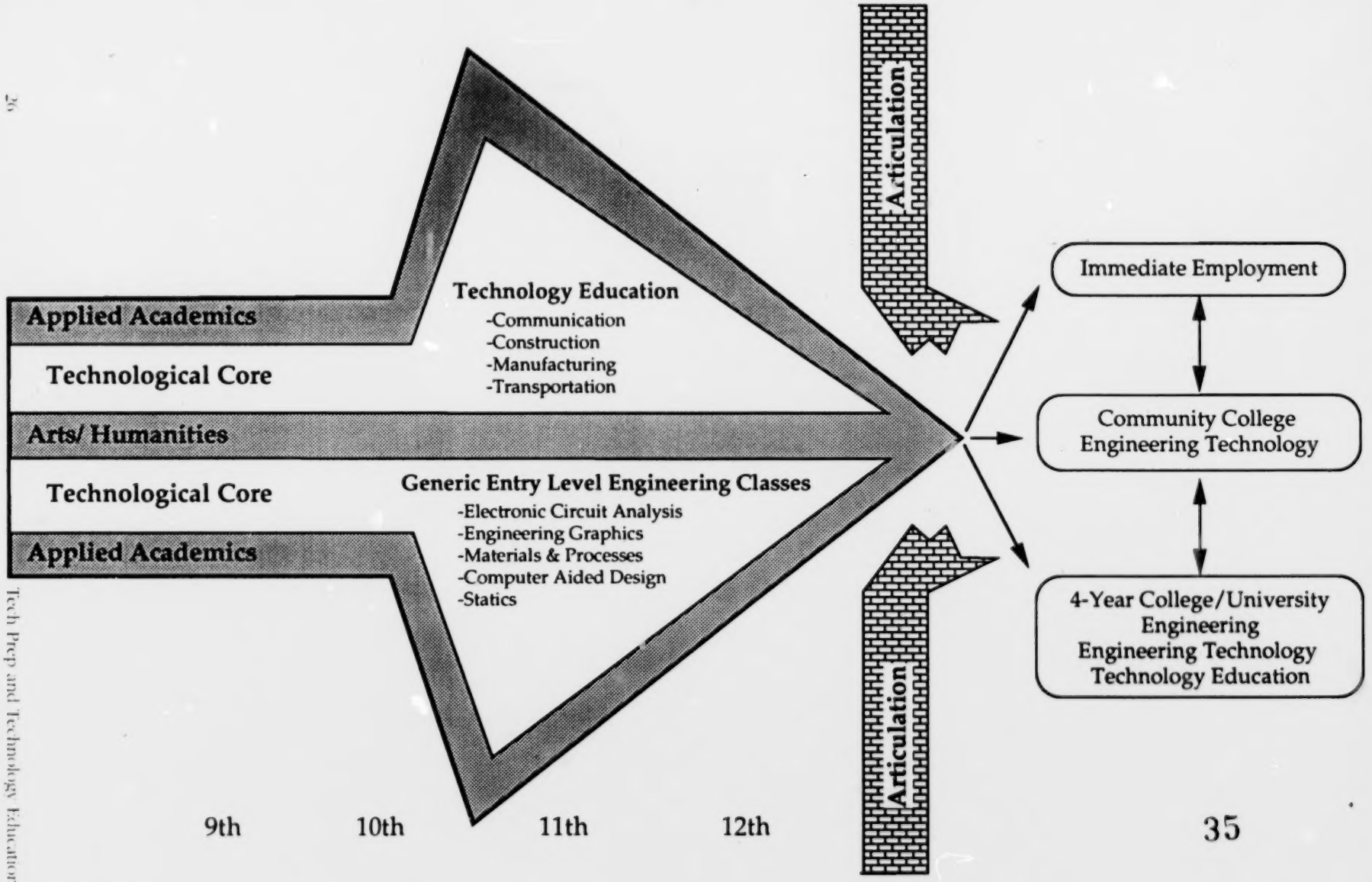


Figure 8: Education for Competitive Literacy

| SUBJECT | REQUIRED CREDITS | FRESHMAN | SOPHOMORE | JUNIOR | SENIOR |
|---|---|---|---|---|---|
| Math | 4 | Applied Math I<br>Tech. Math<br>Algebra Ia<br>Algebra I | Applied Math II<br>Tech. Math<br>Algebra Ib<br>Algebra II | Algebra II<br>Tech. Math<br>Algebra II<br>Geometry | Geometry<br>Tech. Math<br>Geometry<br>Pre-Calculus |
| English | 4 | Language Arts | Language Arts | Language Arts | Language Arts |
| Science | 3 | Science 3<br>(Earth, Physics, Bio, Chem)<br>Science 3 | Science 4<br>(Earth, Physics, Bio, Chem)<br>Science 4 | Principles of Tech<br>.(Tech Center)<br>Advanced Science | Principles of Tech.<br>.(Tech Center) |
| Social Science | 3 | Social Science | Social Science | Social Science | |
| Health | 1 | | Health | | |
| Phys. Ed. | 1 | Phys. Ed. | | | |
| Interdisplicinary Arts | 1 | Music (1 Sem.) | Art (1 Sem.) | | |
| Other<br>(Statics<br>Mat/Processes<br>Eng Graphics<br>& 2 Others) | 4 | Materials /Processes<br>Public Speaking (1 Sem.)<br>Applied Comm. (1 Sem.)<br>Keyboarding (1 Sem.)<br>Computer Sci. (1 Sem.) | Engineering Graphics | | Statics |
| Tech Center | 5 | (Plus one unit of scince from above)<br>Principles of Tech I/II | | Tech Center<br>Computer Graphics<br>Transportation (1 Sem.)<br>Communication (1 Sem.)<br>Principles of Tech I | Tech Center<br>Electronics<br>Manufacturing (1 Sem.)<br>Construction (1 Sem.)<br>Principles of Tech II |
| TOTAL | 26 | | | | |



Figure 9: High School Tech Prep Curriculum For Engineering Careers/Competitive Literacy

"neglected majority" as well as college prep students into technical classes, and prepares graduates for a variety of engineering and technology related college programs.

## Tech Prep Graduate Options

High school graduates of the NCWV "engineering technology" tech prep curriculum have a variety of career options. Graduates may seek **direct employment in industry** as a much better prepared (semi-skilled) worker. Another option is to articulate into one of ten Fairmont State College associate degree engineering technology programs and graduate for employment opportunities as an **engineering technician**. A third option is for the student to continue after completing the associate degree into one of nine plus (+) 2 engineering technology baccalaureate programs and graduate for employment opportunities as either an **engineering technologist or an engineer**.

Graduates of West Virginia TAC/ABET accredited baccalaureate degree programs may qualify to take their **Fundamentals of Engineering** (F.E.) exam during their senior year of study and become certified engineering interns after a minimum of two years of experience under a licensed engineer. Four years after becoming an engineering intern, graduates can then take the **Professional Engineering** (P.E.) examination that relates to their specific branch of engineering. The successful completion of these examinations and professional work experience will lead to **professional engineering certification**.

A final option for students in this tech prep program is articulation into the **technology teacher education program** for eventual employment as a technology education teacher. Greater enrollments in technology teacher education programs will certainly be promoted. This logic could also extend to teacher education programs in other disciplines as well.

## North-Central West Virginia Tech Prep Articulation

The North-Central West Virginia (NCWV) tech prep articulation model provides up to 27 credit hours into ten technology and engineering technology associate degree programs, and nine engineering technology bachelor's degree programs. Twenty-three (23) credit hours will also be articulated into the technology teacher education program as shown in Figure 10.

The procedure for receiving advanced standing and college credit reflects the criteria for articulation discussed in an earlier section of this monograph. Once the criteria are met, the college transcript will reflect credit that counts toward graduation. A mark of "P" or "CR" will appear on the transcript for each articulated class and will not be used in the calculation of the final grade point average of the student.

While students can articulate up to 27 credit hours, it is anticipated (due to economic and personnel limitations within each of the twelve NCWV tech prep county school systems) that the norm will be approximately 15 credit hours. This significant number of credit hours can lead to questions concerning the ***length of time*** it will take for a tech prep student to complete a post-secondary degree and whether or not ***enhanced skills*** can be incorporated into the college curriculum to replace the credits articulated from the secondary schools.

A comparison of time-shortened and skill enhanced characteristics of the "general" high school and the NCWV Tech Prep "engineering technology" curricula are shown in Figure 11. The existing ***general high school curriculum*** will articulate zero (0) credit hours into a college degree program. Since most graduates of the "general" high school curriculum have not been adequately prepared to purse a college degree, they

| High School Class | Fairmont State College Class | Credit Hours | |
|---|---|---|---|
| | | Eng Tec | Tech Education |
| **I. Applied Academic** | | | |
| Language Arts (4 yrs.) | ENGL 109<br>Technical Report Writing | 3 | - |
| Algebra/Tech Math/<br>Geometry (4 yrs.) | MATH 101<br>Applied Technical Math | 3 | 3 |
| Prin. of Tech. I (1 yr.)<br>Prin. of Tech. II (1 yr.) | PHSCI 104<br>Physical Science Physics | - | 2 |
| **II. Generic Technology** | | | |
| Engr. Graphics (1 yr.) | DRF 100<br>Engineering Graphics | 3 | 3 |
| Comp. Graphics (1 yr.) | DRF 270<br>Computer Graphics | 3 | 3 |
| Electronics (1 yr.) | ELE 100<br>Circuit Analysis | 3 | 3 (elective) |
| Mat. & Proc. (1 yr.) | MAT 100<br>Materials & Processes | 3 | 3 |
| Statics (1 yr.) | MEC 100<br>Statics | 3 | - |
| **III. Literacy** | | | |
| Con. (1/2 yr.) / Mfg. (1/2 yr.) | ST:Elective | 3 | 3 (elective) |
| Tran. (1/2 yr.) / Com. (1/2 yr.) | ST:Elective | 3 | 3 (elective) |
| | | **TOTAL 27** | **23 Cr.** |

Figure 10: Engineering Technology Articulation Model for the North Central WV Tech Prep Consortium

must take approximately one (1) year of academic remediation in math, communication and science related skills. Further, their associate and bachelor's degree programs will require at least two (2) years each to complete.

Barring any unforeseen circumstances (such as excessive withdrawals or sickness), it will take a graduate of a "general" high school curriculum at least three (3) years to complete an associate degree and an additional two (2) years to complete a related 2 + 2 bachelor's degree program. Further, neither the associate or bachelor's degrees are enhanced with any advanced level skills deemed necessary for a world-class workforce.

The NCWV "engineering technology" tech prep curriculum time-shortens both the associate and bachelor's degrees by at least one year because the need for academic remediation is eliminated. Further, skill enhancement can be added to both the associate and bachelor's degree programs to replace the credit hours that were taught at the secondary level.

Associate degree programs can be enhanced by allowing students with appropriate prerequisites to articulate advanced level classes from the bachelor's degree program. The bachelor's degree program can also be enhanced by allowing students to take additional technical electives, select a minor program of study from another college division (i.e. computer science, management, etc.), or complete an additional technology related associate degree program.

A graduate of the NCWV "engineering technology" tech prep curriculum would take about two (2) years to complete an associate degree and two (2) or less years to complete a related 2 + 2 bachelor's degree program. Parents and students can save educational expenses through a time-shortened curriculum and graduates can benefit from skill-enhanced options in both the associate and the bachelor's degree programs.

# North-Central West Virginia Tech Prep Project

## General H.S. Curriculum

| Years | High School General Curriculum<br>0 Articulated Credits |
|---|---|
| 1 | Academic Remediation<br>• Math, Communication, Science |
| 2 | Associate Degree<br>• Existing (Non-Enhanced) Associate Degree |
| 2 | Bachelor's Degree<br>• Existing (Non-Enhanced) +2 B.S. Credits |

5 Total Years

## NCWV Tech Prep Curriculum

| Years | High School Tech Prep Curriculum<br>Max. 27 Articulated Credits<br>(Average 15 Articulated Credits) |
|---|---|
| | |
| 2 | Associate Degree<br>• 1-1.5 Years of Remaining Non-Articulated) Credits<br>• 1-0.5 Year of ***Enhanced*** Skills from + 2 B.S. Degree |
| 2 | Bachelor's Degree<br>• 1-1.5 Years of Remaining +2 B.S. Degree Credits<br>• 1-0.5 Year of ***Enhanced*** Skills from Technical Electives, Minor, or Additional A.S. Degree |

4 or Less Total Years



Figure 11: Time-Shortened and Skill Enhanced Curricular Comparisons



Tech Prep and Technology Education

# CERTIFICATION REQUIREMENTS FOR H.S. TECH PREP TEACHERS

| Fairmont State College Class | Minimum Certification |
|---|---|
| **I. APPLIED ACADEMIC:** | |
| • Tech. Report Writing | English/Applied Communication Exp. |
| • Applied Tech. Math | Mathematics with Applied Math Exp. |
| • Phys. Science Physics | Physics or General Science with Prin. of Technology Expertise |
| **II. GENERIC ENTRY LEVEL TECHNICAL:** | |
| • Engineering Graphics | Vocational Drafting or *Technology Eucation* with Drafting Spec. |
| • Computer Graphics | Vocational Computer Drafting or *Tech. Educ.* with Computer Graphics Expert. |
| • Circuit Analysis I | Vocational Electronics or *Technology Educ.* with Electronics Specialization |
| • Statics | Math or Science (preferably physics) or an Engineering Background |
| • Materials/Processes | *Technology Education* or Maufacturing Background |
| **III. LITERACY:** | |
| • Construction | *Technology Education* with Epertise in Construction Systems |
| • Manufacturing | *Technology Education* with Expertise in Manufacturing Systems |
| • Transportation | *Technology Education* withExpertise in Transportation Systems |
| • Communication | *Technology Education* withExpertise in Communication Systems |

Figure 12: Certification Requirements for Tech Prep Teachers

# IMPLICATIONS OF TECH PREP FOR TECHNOLOGY EDUCATION

Technology education has a meaningful contribution to make toward transforming the "neglected majority" into a world-class workforce. When technology education becomes a varsity player with applied academic and vocational education, tech prep can provide a(n):

- **balanced technical core** that will enable students achieve **ALL** SCANS competencies,
- powerful **catalyst for change** that can significantly reduce the theory- practice gap in the field,
- viable solution to the **curricular squeeze** overwhelming teacher education programs across the nation,
- **excellent recruitment tool** for teacher education programs,
- window of opportunity to **reverse the trend toward extinction** of both technology and vocational education, and
- meaningful contribution to the battle for economic competitiveness.

Each of the these points will be discussed below in greater detail.

## Balanced Technical Core

The blending of **literacy** in technology (technology education), **efficiency** in technology (vocational education), and post-secondary **professional education** in technology can provide a strong balanced technical core for the tech prep curriculum. A balanced technical core (breadth as well as depth) is essential for students to achieve all SCANS competencies, to have great career flexibility at the college level, to obtain competitive literacy, and to become contributing members of a **world-class workforce**.

Appropriate combinations of technology education and vocational education can produce a synergistic effect on the study of technology at the secondary level. Each of these ways of studying technology has its own strengths and weaknesses as described earlier. The strengths of both can easily cancel weaknesses and lead to **competitive literacy**. However, a technical core focus on one (such as the conventional vocational format described earlier) will allow curricular weaknesses to impede progress toward that same goal.

The technical core promoted in this monograph contains four one-semester **literacy** courses and five one-year **generic-technical classes**. The certification requirements for high school teachers in each of these classes are shown in Figure 12. The literacy courses will only be taught by certified technology education teachers. The generic entry level technical classes will be taught by either vocational teachers or technology education teachers with certifications in drafting, computer graphics, electronics or significant industrial experience. The only exception in the technical core is statics, which will be taught by a math or science certified teacher or a technical teacher with an engineering background.

The **generic-technical core** has appropriate combinations of literacy as well as efficiency classes in technology.

When combined with college level study in technology, students will experience a well-balanced technical core that includes all three ways of studying technology: **Literacy, Efficiency, and Professional Education.**

## Powerful Catalyst for Change

Perhaps the most significant and persistent problem that faces the technology education profession is the ever widening **theory-practice gap**. A multitude of approaches have been tried over many years to reduce the theory-practice gap. Theory-based models (state curriculum guides, innovative curriculum plans, textbooks, learning activity packets, etc.) have been developed, undergraduate programs have been improved, and countless short-term in-service training programs have been implemented. However, significant change has not occurred in the field.

According to most national surveys, the most commonly taught secondary level literacy classes in technology continue to be **woods, metals, and drawing**. Similar classes were taught as far back as the late 1800's when a form of education called ***manual training*** was common in the public schools.

Past efforts to bring about change have failed because change agents have focused primarily on changing teachers and not on **changing the overall education system** in the secondary schools. According to Deming (1986), individuals (teachers) who are involved with a process (education) have control of only about six (6) percent of the factors that bring about change in their work environment. Management (the administration), on the other hand, has control of at least ninety-four (94) percent of change related factors. (p. 315)

While conventional teachers deserve some blame for not changing, the majority of the blame lies in the **system** that reinforces conventional practice. This system is controlled in large part by the administration. Therefore, lasting change will only occur if the administration changes the system of education. **Tech prep is a change in the system.**

Tech prep is a change in the education system for the "neglected majority." The new tech prep "majority" should be provided for the first time with a **planned four-year sequence** of high school courses that lead to a career goal. Academic instruction is made **practical and relevant.** Technology education and a generic-technical form of vocational education become **required** and essential components of the high school curriculum. **Funding** for this portion of the student population becomes a priority. All parties that reinforce change are involved (principals, counselors, parents and other teachers) and **continuous improvement** (reduction of the theory-practice gap) is built into the system.

Implicit in the tech prep articulation process is a methodology for interfacing theory-based college level instruction with secondary level practice. Technology education course materials are developed through close cooperation between secondary level and college level teachers. A consensus on course descriptions, outlines, goal statements, competency statements, and final competency examinations is developed during this process. Secondary level teachers are certified to teach college level coursework; which in itself provides a psychological boost to the ego of those teachers. Accountability is obtained through final competency examinations developed by college personnel with input from secondary teachers.

Empirical data (percentages of students passing the competency examinations) can be provided as feedback to teachers and administrators to identify areas of needed improvement. Finally, yearly articulation meetings and

in-service training workshops can be used to evaluate progress, to modify objectives and improve activities so that continued theory-practice compatibility can be maintained.

## Solution to the Curricular Squeeze

There are three basic components to a technology teacher education curriculum:

1. a **general studies** core,
2. a **professional education** core, and
3. a **subject specialization** core (technology education technical classes).

Significant increases in the sizes of the general studies and professional education cores have occurred in recent years, due largely to pressure from national and regional accrediting associations.

The resulting increases have required administrators of undergraduate programs to consider either extending their programs to a fifth year or significantly reducing the number of technical core classes required for graduation. Both options are less than desirable. A fifth year will have a negative impact on already sagging teacher education enrollments and a significant reduction in the technical core will seriously compromise the technical competence of graduates.

A properly designed tech prep curriculum can provide a solution to this problem. The **generic-technical format**, as advocated in this monograph, can provide from twenty to thirty credit hours of articulated coursework into a technology teacher education career option. The same entry level classes required in the engineering technology career option (engineering graphics, computer graphics, materials and processes, circuit analysis, communication, construction, manufacturing, transportation, etc.) are also required in the teacher education program. Shifting these classes to the high school level will allow students to maintain current levels of competence and graduate from teacher education programs in four or less years, depending on the degree program.

## Excellent Recruitment Tool

The inclusion of a **technology education career option** can easily be accomplished in an engineering related career cluster with a **generic-technical** format as discussed above. Recruitment research indicates that parents and high school teachers have the greatest influence on individuals who eventually decide to become technology education teachers. However, a systematic effort to capitalize on this knowledge really hasn't occurred. A technology education tech prep option will lead to active marketing of this career opportunity to parents, counselors, and teachers.

Typically, during the eighth grade, students and parents are provided with detailed information relating to three high school program options: **college prep**, **tech prep**, and **vocational prep**. The vocational option is also sometimes referred to as "occu prep" or "mastery prep". The information provided to students and parents explains advantages and disadvantages of each program option. It also provides information about post secondary education opportunities and regional/national job outlooks for graduates from each program option.

The student who selects the **tech prep option** is then provided with an opportunity to select a career cluster such as engineering technology, health/human services, business/commerce, agriculture, arts/humanities, or **teacher education**. Students who select the teacher education option can select the specific field of teacher education that they would like to pursue (such as **technology**

**education**). The students should than be given a four-year plan of courses by their counselor that will provide them 1) with the academic prerequisites to enter college and 2) a significant amount of entry level coursework to articulate into their chosen career field.

Conventional tech prep marketing strategies are supported by federal, state, and local funding and these strategies can be quite inclusive. The **technology education career option** can be actively marketed with program brochures, video tape promotional advertisements, local and regional guidance counselor workshops, college career days, and many other options. The fact that a technology teacher education career option (promoting between 20 and 30 credit hours of articulated coursework) is provided in print to parents, students, and counselors as a viable career alternative is in itself a major accomplishment for the field. This career option could have a positive impact on recruitment in the technology education profession.

## Reverse the Trend Toward Extinction

National, state, and local proponents of tech prep have consistently stated that their ultimate goal is to replace the general high school curriculum with tech prep curricula. While this goal is desirable, one must remain cognizant of the fact that in most cases, the majority of current industrial arts and technology education enrollment is comprised of students from the general curriculum.

The obvious impact of tech prep curricula without **a required technology education component** is:

- an increase in vocational education enrollments,
- a decrease in technology education enrollments,
- extinction of technology education at the high school level,
- a sharp reduction in demand for technology education teachers,
- a continued decline of enrollment in technology teacher education programs,
- the elimination of greater and greater numbers of technology teacher education programs due to low enrollment and low graduation rates,
- the eventual loss of the field, and
- lost opportunity for a competitively literate world-class workforce.

The inclusion of a required technology education component in the high school curriculum will validate the long sought status of technology education as a BASIC component of liberal education. Philosophy and rationales can be written in infinitum espousing the value of holistic study that leads to technological literacy. However, elective programs (such as technology education) will never really be valued as basic education as long as they remain elective options in the curriculum.

As an elective option, technology education will continue to suffer from lack of respect and the ax of **reduction-in-force** (RIF) policies. As a required component of the tech prep curriculum, a window of opportunity is finally opened for technology education to become a varsity player in the in liberal education of a large segment of the school population and the national battle for economic competitiveness.

## SUMMARY

The quality of public education has become a focal point of criticism during the past decade. Large numbers of high school graduates, specifically those who graduate from the "general" high school curriculum, have simply not been provided with the academic or technical competencies required for direct entry into the workforce or continued education at the post-secondary level.

A new initiative in education, called tech prep, has been proposed as an alternative to the "general" high school curriculum. Tech prep has been described as a parallel college prep curriculum with grade level or above applied academic classes, a core of technical coursework within a specific professional career cluster (such as engineering), and the articulation of entry level applied academic and technical classes that will provide graduates with advanced placement in a related degree program at the post-secondary level.

An effort was made to define the elements of a tech prep technical core that would provide graduates with the SCANS competencies and **competitive literacy** required of a **world-class workforce**. First, two parallel historic lineages of education in technology (general education and occupational education) describing three principle ways to study technology (literacy, efficiency, and post-secondary professional education) were presented. Then, a **technical core** focusing on a holistic understanding of technology and the achievement of entry level technical competencies generic to a wide variety of fields within a specific career cluster was recommended. This technical core would require a blending of technology education, a generic-technical form of vocational education, and professional education (in an engineering related field) to achieve the goal of **competitive literacy.**

The North-Central West Virginia tech prep curriculum model, designed to promote competitive literacy, was then presented. The process of articulation with associate and baccalaureate degree programs in technology, engineering technology, and technology teacher education was described. Further, the flexibility of five alternative career paths for tech prep graduates of this model was discussed.

Finally, advantages for the inclusion of ***technology education*** in tech prep curricula were presented. Included are a balanced technical core, a powerful catalyst for change to reduce the theory-practice gap in the field, a viable solution to the curricular squeeze overwhelming teacher education programs, an excellent recruitment tool for teacher education programs, a window of opportunity to reverse the trend toward extinction of technology education, and an opportunity to become a varsity player in the national battle for economic competitiveness.

The stakes are high. Immediate action must be taken to:

- include technology education as a core requirement in tech prep curricula,
- use SCANS foundations and technical competencies as a benchmark to upgrade high school level technology education systems courses,
- work together with vocational and academic teachers to develop generic-technical based tech prep curricula that will provide entry level articulation to a wide variety of technology related associate and baccalaureate degree programs including technology teacher education, and

- develop generous articulation agreements 20 to 30 credit hour range) that will encourage academic, vocational and technology education teachers to participate and support this effort to change the "neglected majority" into a **competitively literate** majority.

If we as technology educators dare not "seize the day" to become active leaders or followers in this unique educational movement, we will have only ourselves to blame when we are told, in the words of Lee Iacocca, to "get out of the way"!

## A Bright Future

Education in technology can play a vital role in the revitalization of the American educational system. When applied academics are integrated with the holistic study of technology (technology education), the generic entry level skills of a technician (vocational education), and post-secondary professional education in a technology related discipline (such as engineering or engineering technology), a "competitively literate majority" will begin to play a significant role in a brighter economic future of our nation.

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